I.2.1 Cased-hole Logging

The cased-hole logging program is designed to demonstrate integrity of the cement and tubulars, derive the geometry of the wellbore path, and characterize the subsurface temperature gradient.

The following geophysical well logs will be run in the completed cased-hole section of the appraisal well:

Cased Hole (0 – 11,000 feet)

- Cement evaluation and casing inspection tool
- Gyroscopic survey
- Differential temperature survey

Additional diagnostic cased-hole logs may be run at the discretion of the Project Team.

I.2.2 Pressure-Transient Testing

Pressure transient testing may be used to define reservoir properties and evaluate the completion condition of the wells. Step-rate tests and mini-frac tests can be used to define the breakdown pressure of the formations of interest using low volume/high rate injection techniques. Constant rate injection/falloff or production/buildup tests and cross-well interference tests can be used to measure formation transmissibility, storativity, and completion condition of the well(s). A more detailed testing procedure will be developed and conducted in the chosen pilot testing interval following installation of the Injection Well. The various types of transient tests being considered are outlined in the following subsections.

I.2.2.1 Mini-frac Injection Test

A mini-frac injection test, using native or commercial brine, may be performed on the injection interval sand. A mini-frac analysis provides a method of estimating the fracture closure pressure of the formation. This type of analysis quantifies the fracturing process as estimated from the measured pressure decline. The test will provide the in-situ minimum stress that will define a maximum bottomhole pressure for injection tests for reservoir characterization and for CO_2 injection.

The mini-frac test will be initiated at a high rate and pressure in order to quickly break down the formation. Once breakdown has occurred, the injection rate will be stabilized. Following stabilization of the injection rate, injection will continue for fifteen to thirty minutes. Once stable injection has been observed for the estimated time frame, the injection pumps will cease injection. If time and volumes allow, the injection pumps will be stepped down in equal time increments. This will allow for estimation of perforation and near-wellbore friction losses. The relationship between the decreasing rate and pressure results in a determination of near-wellbore pressure losses.

I.2.2.2 Step-rate Injection Test

A step rate injection test, using formation or commercial brine, may be performed on the injection interval sand. An initial low-rate, low-injection pressure injectivity test may be performed ahead of the step rate test to assess receptivity of the potential injection interval. From these data, a detailed step rate test plan will be designed and performed, so that test injection pressures span the range from the measured initial shut-in to the parting pressure of the injection interval.

If the pre-injection test is performed, the step rate test will then be initiated following pressure recovery from the low-rate, low-pressure pre-test. Injection will be initiated and stepped up in equal rate increments using equal time intervals (approximately 30 minutes per step). The 30-minute increments should be sufficient to allow for proper rate stabilization of the injection pump(s) and allow sufficient time to overcome wellbore storage effects between each rate change (especially at the low rates).

The step rate test will be designed for either 5 steps (20 percent rate increase increments to 100 percent maximum rate) or 8 steps (15 percent rate increase increments to 100 percent maximum rate) to gather a sufficient number of points for valid test analysis. The step rate test results will be used to limit the maximum bottomhole injection pressure and surface injection pressure so that the reservoir and seal formations are not fractured.

I.2.2.2 Constant Rate Injection/Falloff Test

A two-well constant rate interference pressure transient test using formation or commercial brine may be performed prior to CO_2 injection in order to investigate formation properties (permeability & storativity), presence/absence of boundaries, and wellbore conditions (skin,

completion efficiency, and wellbore storage). The injection brine will be filtered to remove suspended solids (e.g., sand, silt, drilling mud) and temporarily stored in an above ground frac-tank. Fluorescein will be added to the water to trace the fluid before injecting the tagged water back into the injection well at a constant rate. Downhole pressure and temperature will be monitored in both the injection and observation wells during the injectivity test. The pressure transient response observed during injection and the pressure fall-off period will be analyzed to determine well and formation characteristics.